MODEL 43-01
WIDEBAND
TRANSMISSION TEST SET

OPERATING MANUAL

HLI HEKIMIAN LABORATORIES INC.

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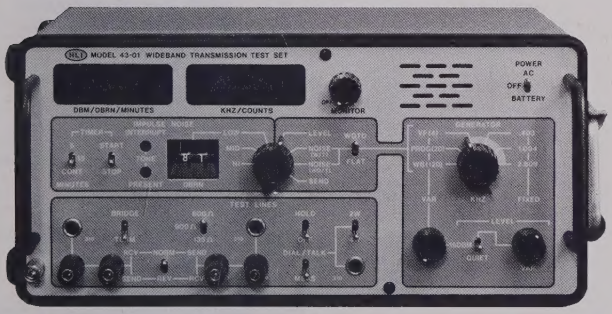
MODEL 43-01
WIDEBAND TRANSMISSION TEST SET



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OPERATING MANUAL
MODEL 43-01 WIDEBAND TRANSMISSION TEST SET

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1. GENERAL

1.01 This manual contains information for the installation and operation of the HLI Model 43-01 WIDEBAND TRANSMISSION TEST SET. This section covers the functional description and specifications of the Model 43-01.

DANGER: Hazardous voltages exist inside this instrument.

A. Functional Description

1.02 The Model 43-01 measures level, noise (VF, program and wideband), 3-level impulse noise, elapsed time and frequency. Combined with a variable signal generator and a flexible line interface configuration, the instrument will fill a variety of testing needs. The Model 43-01 is intended to comply with Bell System standards as contained in Bell System Technical Reference PUB 41009 dated May 1975. The instrument is compact (11" x 5-1/4" x 8-1/2") and weighs less than 11 pounds. When equipped with the optional battery the instrument is completely portable.

1.03 Level measurements are made directly in dBm using an average type detector. Noise measurements are made directly in dBrn using a quasi-RMS detector. C-message, program, 50 kBit (497 F), 3 kHz flat, 15 kHz flat and 50 kHz flat weighting filters are front panel selectable. The operator can select the holding tone notch to be in line with any of the weighting filters.

The Model 43-01 measures the number of times impulse noise (defined as any excursion of a band-limited signal above a preset threshold) occurs within a specified time period. The instrument is calibrated in dBrn to read the peak value of the received signal. The Bell Standard counting rate is provided. One set of thumbwheel switches allows the setting of low thresholds for impulse noise (metallic) tests. The LOW/MID, MID/HI threshold spread is 4 dB. Any of the noise weighting filters can be used for impulse noise testing.

Frequency measurements can be made from 30 Hz to 19.999 kHz with 1 Hz resolution in the VF mode and from 30 Hz to 120 kHz with 10 Hz resolution in the program and wideband modes.

1.04 Dual digital displays simultaneously present fully autoranged level/noise and manually ranged frequency measurements or impulse noise counts and elapsed time. Level and frequency measurements can be made

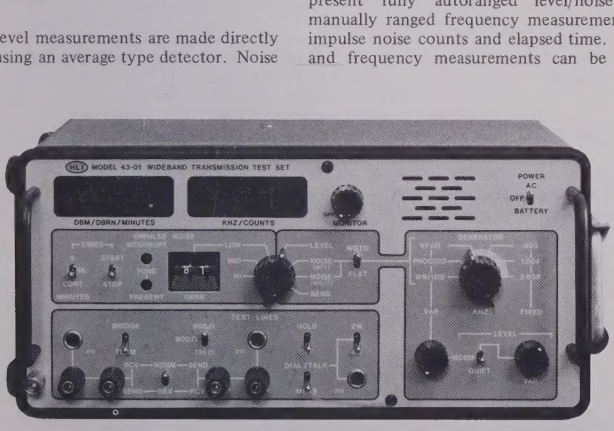


Figure 1. Model 43-01 WIDEBAND TRANSMISSION TEST SET

during impulse noise tests without affecting the impulse noise counting. A loss-of-tone indicator shows if the holding tone was lost at any time during an impulse noise test.

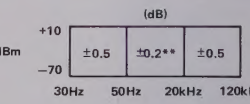
1.05 The signal generator provides continuous frequency coverage in three overlapping ranges. For noise measurements, both a 1004 Hz holding tone and a quiet termination are provided. Additionally, the instrument features fixed frequencies of 403 Hz and 2809 Hz. The operator can select a fixed level, variable level or a quiet termination via a single, three position toggle switch.

1.06 Line interface can be made to either the 310 jacks or the five-way binding posts on the front panel. The instrument is supplied with 135 Ω, 600 Ω and 900 Ω selectable send/receive impedances, line bridging and termination selection capability and an audio monitor. A full 2W/4W dial/talk capability with dual electronic hold circuits is provided.

B. Specifications

1.07 Specifications for the Model 43-01 are contained in Table A.

TABLE A. MODEL 43-01 SPECIFICATIONS*

GENERAL	
Measurements	Level (dBm), noise (dBrn), 3-level impulse noise, time (min.), frequency (kHz)
Displays	Dual display
Generator	Sine wave, fixed and variable frequency, fixed and variable level
Dial/Talk	Full 2W/4W capability with dual electronic hold
Line Select	Send/receive transfer switch
Audio Monitor	Front panel volume control and ON/OFF switch
INPUT	
Impedance	135 Ω, 600 Ω, 900 Ω, bridged (balanced)
Return Loss	>30 db, 200 Hz to 20 kHz (600 Ω, 900 Ω)
Balance	>80 db at 60 Hz >70 db at 540 Hz >60 dB at 4 kHz
Line Hold	Electronic hold, nominal 26 mA
LEVEL MEASUREMENT	
Frequency Range	30 Hz to 120 kHz
Measurement Range	-90.0 dBm to +10.0 dBm, full autoranging
Accuracy	
Detector Type	Average

**±0.1 dB at 1000 Hz for levels between 0 and -19 dBm

TABLE A. MODEL 43-01 SPECIFICATIONS (Cont.)*

NOISE MEASUREMENT	
Weighting Filters	C-Message, 3 kHz flat, program, 15 kHz flat, 50 kBit (497 F), 50 kHz flat, 1010 Hz notch
Measurement Range	0 to +100 dBrn (noise), full autoranging
Accuracy	±1 dB (noise), +10 to +100 dBrn
Detector Type	Quasi-RMS
IMPULSE NOISE MEASUREMENT	
Measurement Range	40 dBrn to 107 dBrn
Low Threshold Settings	40 dBrn to 99 dBrn
Accuracy	±1 db
Weighting Filters	C-Message, 3 kHz flat, program, 15 kHz flat, 50 kBit, 50 kHz flat
Lo/Mid, Mid/High Threshold Spread	4 dB
Maximum Count Rate	7 counts per second (Bell Standard)
Count Capacity	9999
Timer	5, 15 minutes or continuous
FREQUENCY MEASUREMENT	
Frequency Range	30 Hz to 120 kHz; 1 Hz resolution to 19.999 kHz in VF mode, 10 Hz resolution in program and wideband modes
Level Range	−40 dBm to +10 dBm
Accuracy	±0.005% ±1 least significant digit
S/N Requirement	⩾20 dB
GENERATOR	
Frequency Range	50 Hz to 120 kHz
Modes	VF: 50 Hz to 4.8 kHz Program: 250 Hz to 24 kHz Wideband: 1250 Hz to 120 kHz 403 Hz, 1004 Hz, 2809 Hz, crystal controlled
Level Range	−40 dBm to +10 dBm, continuously adjustable −16 dBm, fixed (set at 100 Hz) Quiet termination
Distortion	>60 dB, 1004 Hz fixed >50 dB, 200 Hz to 4000 Hz >40 dB, 50 Hz to 120 kHz
Impedance	135 Ω, 600 Ω, 900 Ω (balanced)
Return Loss	>30 dB, 200 Hz to 20 kHz (600 Ω)

TABLE A. MODEL 43-01 SPECIFICATIONS (Cont.)*

CONNECTORS	
Send-Receive	310 type jacks, 5-way binding posts
4W Talk (optional)	310 type jack
2W Dial/Talk (optional)	310 type jack
POWER	105-130 V ac 57-63 Hz, 15 Watts
SIZE	11" (27.94 cm.) W x 5¼" (13.34 cm.) H x 8½" (21.59 cm.) D, less cover
WEIGHT	10.3 lbs. (4.6 kg.) ac only 12.5 lbs. (5.7 kg.) with battery pack
OPTIONS	.01 220 V ac operation .02 Rechargeable battery pack

*All stated and unstated specifications are intended to comply with Bell System standards as contained in Bell System Technical Reference PUB 41009 dated May 1975.

HLI reserves the right to make changes in specifications at any time without notice.

2. POWER CONSIDERATIONS

A. AC POWER

2.01 This section contains information pertaining to the ac power connection and power source compatible with the Model 43-01.

2.02 The Model 43-01 may be operated from a source of 105 V ac to 130 V ac at line frequencies from 57 Hz to 63 Hz. The fuse, located on the rear panel as shown in Figure 2, is a 0.5 ampere slow-blow. A small flat-blade screwdriver is used to replace the fuse.

2.03 The Model 43-01 is supplied with a detachable three-conductor power cable (Belden P/N KH-8828R) which, when plugged into an appropriate receptable (located on the rear panel as shown in Figure 2), grounds the chassis to the power line ground. To retain this protective feature when the power cable is plugged into a two-wire outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to an appropriate ground.

2.04 If for any reason the chassis cannot be grounded through the power cable, it is recommended that the Model 43-01 be grounded via the front panel (refer to Figure 3) ground post.

2.05 When the unit is received, it is recommended that the self-test in Section 10 be performed to determine that the unit is electrically operational.

Figure 2. Rear Panel AC Power Receptacle and Fuse

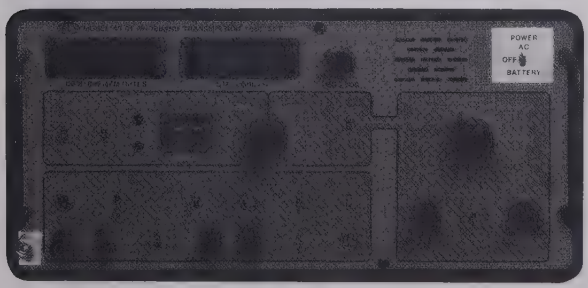


Figure 3. Front Panel AC POWER and BATTERY Switch and Ground Post

B. Model 43-50 Battery Charger

2.06 This section contains information pertaining to the Model 43-50 battery charger. Earlier Model 43-01 units incorporated this capability only if they were ordered along with the Model 43-50. This capability is now standard with all Model 43-01's.

2.07 The Model 43-50 contains four 1.2 ampere-hour nickel-cadmium batteries. To recharge these batteries, connect the battery charging cable to the Model 43-50 front panel charger connector and to the charger connector on the rear panel of the Model 43-01. With the cable connected, the batteries will be recharging whenever the Model 43-01 power cord is connected to an ac line. The batteries will recharge faster if the power switch on the Model 43-01 is set to the OFF position. Additional information can be found in Section 3 of the Model 43-50 Operating Manual (43-50-M20).

C. Model 43-01 Battery Pack (Option .02)

2.08 This section contains information on the Model 43-01 Rechargeable Battery Pack, Option .02. When fully charged, the battery pack will operate the Model 43-01 for approximately four hours.

2.09 The rechargeable battery pack consists of three independent nickel-cadmium batteries. Two of these are 9 V batteries with eight matched cells and a cutoff point of 8.8 V dc. At full charge the battery voltage may be as high as 11.0 V dc. The 5 V battery has four matched cells and a cutoff point of 4.4 V dc. When fully charged the voltage may be as high as 5.5 V dc.

2.10 The battery chargers are active when the unit is connected to the ac line. The batteries can be recharged simultaneously with ac operation, but will charge faster when the Model 43-01 power switch is set to the OFF position. Fully discharged batteries can be fully recharged overnight (14-16 hours) at 25°C with the power switch set to OFF.

3. CONTROLS, JACKS AND DISPLAYS

3.01 This section contains the description of all toggle switches, knobs, jacks, displays and the speaker on the Model 43-01. Refer to Figure 4 for the location of all items discussed.

A. Toggle Switches

(1) WGTD/FLAT - With the switch set to the WGTD position the user can select C-message, program, or 50 kBit (497F) noise weighting filters. With the switch set to the FLAT position the user can select 3 kHz flat, 15 kHz flat, or 50 kHz flat noise weighting filters.

(7) IMPULSE NOISE TIMER START/STOP - When the switch is momentarily pressed to the START position, the impulse noise timer will start and the Model 43-01 will be able to accumulate impulse noise counts. When the switch is momentarily pressed to the STOP position, the impulse noise timer will stop and the Model 43-01 will be unable to accumulate any additional impulse noise counts.

(8) IMPULSE NOISE TIMER 5/15/CONT MINUTES - With the switch set to the 5 position the impulse noise timer will automatically stop 5 minutes after the START/STOP switch is momentarily pressed to the START position. Setting the switch to the 15 position causes the impulse noise timer to automatically stop 15 minutes after the START/STOP switch is momentarily pressed to the START position. With the switch in the CONT position the impulse noise timer will continuously count after the START/STOP switch is momentarily pressed to the START position. The timer will stop when the START/STOP switch is momentarily pressed to the STOP position.

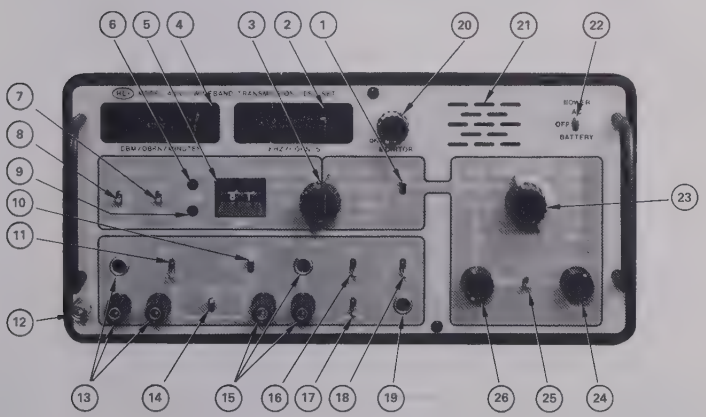


Figure 4. Controls, Jacks and Displays

(10) 600 Ω/900 Ω/135 Ω - Selects send/receive terminating impedances of 600Ω, 900 Ω, or 135 Ω.

(11) BRIDGE/TERM - Provides termination of both the send and receive lines when set to the TERM position. When set to the BRIDGE position the Model 43-01 is set to bridge across the receive line.

(14) NORM/REV - When set to the NORM position the jack to the right of the switch is the send jack (15) and the jack to the left of the switch is the receive jack (13). When set to the REV position the functions of the jacks are reversed.

(16) HOLD/OFF - When set to HOLD dual electronic hold circuits are placed across the send and receive lines (during 2-wire dial/talk operation, the hold circuit will not be across the send line).

(17) DIAL/TALK/MEAS - When set to the DIAL/TALK position the user can perform both 2-wire or 4-wire dial/talk functions. When set to MEAS the Model 43-01 is set to perform circuit measurements.

(18) 2W/4W - Sets up dial/talk for 2-wire or 4-wire operation. When set to the 2W position the Model 43-01 directly accesses the send line for 2-wire (wet) and double 2-wire (wet) facilities. When set to 4W the Model 43-01 provides talk battery for 4-wire (dry) facilities.

(22) AC/OFF/BATTERY (Battery Optional) - Three position switch that controls power to the unit. If your Model 43-01 has the battery option, the BATTERY position should only be used if ac power is not available. The battery will be charging whenever the ac power cord is plugged in.

(25) VAR/-16DBM/QUIET - With the switch set to the VAR position the send level is adjustable from −40 dBm to +10 dBm. When the switch is in the −16 DBM position the send level is a fixed −16 dBm. Setting the switch to QUIET provides a quiet termination at the send jack for noise measurements.

B. Knobs

(3) Measure Function Knob - This knob performs the listed functions when set to the following positions:

HI - Left-hand display will show the elapsed time of the impulse noise measurement. Right-hand display will show the number of times an impulse noise occurrence exceeded the high threshold (low threshold setting +8 dB).

MID - Left-hand display will show the elapsed time of the impulse noise measurement. Right-hand display will show the number of times an impulse noise occurrence exceeded the mid threshold (low threshold setting +4 dB).

LOW - Left-hand display will show the elapsed time of the impulse noise measurement. Right-hand display will show the number of times an impulse noise occurrence exceeded the low threshold (set by the IMPULSE NOISE DBRN thumbwheel switch (5)).

LEVEL - Left-hand display will show the received level in dBm referenced to the selected terminating impedance. Right-hand display will show the received frequency in kHz.

NOISE (W/T) - Left-hand display indicates the level (expressed in dBrn) of the notched noise after filtering by the selected noise weighting filter. Right-hand display will be blanked.

NOISE (WO/T) - Left-hand display shows the level (expressed in dBrn) of the noise after filtering by the selected noise weighting filter. Right-hand display will be blanked.

SEND - Left-hand display will show the send level in dBm referenced to the selected line impedance. Right-hand display will show the send frequency in kHz.

(5) IMPULSE NOISE DBRN Thumbwheel Switch - Sets the desired low threshold, from 40 dBrn to 99 dBrn, for impulse noise measurements.

(20) MONITOR - With knob set to the OFF position the audio speaker on the front panel will be shut-off. By turning the knob clockwise from the OFF position the volume from the speaker will be increasing.

(23) GENERATOR Knob - The GENERATOR knob is a multi-purpose control. When the Model 43-01 is receiving the knob is used to select the desired noise weighting filter. When the Model 43-01 is sending the knob is used to select the desired variable frequency range or the desired fixed frequency. This knob also controls the frequency range of the frequency counter. With knob in the following positions the corresponding function will be realized.

WB (120) - With the Model 43-01 in the noise measurement mode the wideband noise weighting filters [50 kBit (497F) or 50 kHz flat] are selected, depending upon the position of the WGTD/FLAT toggle switch. With the Model 43-01 in the send mode, the 120 kHz variable generator range (1250 Hz to 120 kHz) is selected. Also selects the 199.99 kHz frequency measurement range.

PROG (20) - In the noise measurement mode the program noise weighting filters (Program or 15 kHz flat) are selected, depending upon the position of the WGTD/FLAT toggle switch. In the send mode the 20 kHz variable generator range (250 Hz to 24 kHz) is selected. Selects the 199.99 kHz frequency measurement range.

VF (4) - In the noise measurement mode the voice frequency noise weighting filters (C-message or 3 kHz flat) are selected, depending upon the position of the WGTD/FLAT toggle switch. In the send mode the 4 kHz variable generator range (50 Hz to 4.8 kHz) is selected. The frequency counter's measurement range is set at 19.999 kHz.

.403 - Selects the 403 Hz fixed send frequency. In this position the voice frequency noise weighting filters (C-message or 3 kHz flat) are selected, depending upon the position of the WGTD/FLAT toggle switch. The frequency counter's measurement range is set at 19.999 kHz.

1.004 - Selects the 1004 Hz fixed send frequency. In this position the voice frequency noise weighting filters (C-message or 3 kHz flat) are selected, depending upon the position of the WGTD/FLAT toggle switch. The frequency counter's measurement range is set at 19.999 kHz.

2.809 - Selects the 2809 Hz fixed send frequency. In this position the voice frequency noise weighting filters (C-message or 3 kHz flat) are selected, depending upn the position of the WGTD/FLAT toggle switch. The frequency counter's measurement range is set at 19.999 kHz.

(24) LEVEL VAR - Used to adjust the send level from -40 dBm to +10 dBm.

(26) VAR - Used to adjust the send frequency from 50 Hz to 4.8 kHz in the VF (4) mode, 250 Hz to 24 kHz in the PROG (20) mode and 1250 Hz to 120 kHz in the WB (120) mode.

C. Jacks

(12) Ground Post - The Model 43-01 chassis is normally grounded through the power line. Where three-conductor power line is not available the chassis should be grounded via this post.

(13) Left-Hand Line Interface Jacks - The user can connect to the 310 jack (tip and ring) or the 5-way binding post (tip and ring). The sleeve of the 310 jack is connected to chassis ground. These jacks serve as the receive jacks when the NORM/REV switch is set to NORM and as the send jacks when the NORM/REV switch is set to REV.

(15) Right-Hand Line Interface Jacks - The user can connect to the 310 jack (tip and ring) or the 5-way binding post (tip and ring). The sleeve of the 310 jack is connected to chassis ground. These jacks serve as the send jacks when the NORM/REV switch is set to NORM and as the receive jack when the NORM/REV switch is set to REV.

(19) DIAL/TALK 310 Jack (Optional) - This jack is provided for the connection of a lineman's handset (butt-in), other dialing facility or a headset during dial/talk operations. The sleeve of this 310 jack is connected to chassis ground.

D. Displays and Speaker

(2) Right-Hand Display - This display indicates frequency in KHZ when the measure function knob is set to LEVEL or SEND. It will indicate the number of impulse noise occurrences above the low, mid and high thresholds when the measure function knob is set to LOW, MID and HI, respectively. When the measure function knob is set to NOISE (W/T) or NOISE (WO/T) this display will be blanked.

(4) Left-Hand Display - This display indicates level in dBm when the measure function knob is set to LEVEL or SEND. It will indicate the level of the received noise when the measure function knob is set to NOISE (W/T) or NOISE (WO/T). Finally, it will show the elapsed time, in minutes, of an impulse noise measurement when the measure function knob is set to HI, MID or LOW.

(6) IMPULSE NOISE TONE INTERRUPT - This indicator will light and stay lit if the holding tone is lost during an impulse noise measurement.

(9) TONE PRESENT - This indicator will light whenever a valid holding tone is present.

(21) Speaker - The speaker provides various audible signals depending upon the position of the measure function knob. When the measure function knob is set to HI, MID or LOW the speaker will monitor the signal being fed to the impulse noise circuitry; when the measure function knob is set to LEVEL or SEND the speaker will monitor the receive and send signal, respectively. Finally, when the measure function knob is set to NOISE (W/T) or NOISE (WO/T), the speaker will monitor the signal after it has been conditioned by the noise weighting filters.

4. LINE INTERFACE AND DIAL/TALK, HOLD

4.01 This section describes the line interface connections required to perform the measurements described in subsequent sections of this manual. Also described in this section are the operating instructions for the 2-wire/4-wire dial/talk and hold capabilities of the Model 43-01.

4.02 The Model 43-01 has two sets of balanced terminals and is capable of sending and receiving signals simultaneously. The operator can interface to the Model 43-01 by either the 310 jacks or the 5-way binding posts on the front panel. When using the 310 jacks, be sure to use a WECO 310 plug or equivalent, use of any other type of plug can deform the contacts of the 310 jack. Refer to Figure 5 while performing the procedures in this section.

A. Impedance Selection

4.03 The Model 43-01 provides three commonly used terminating impedances, 135 Ω, 600 Ω, and 900 Ω. The desired impedance is selected by setting the 135 Ω/900 Ω/600 Ω toggle switch to the appropriate position.

Note: Failure to select the proper impedance will cause errors in both the send and receive levels.

B. Bridge/Terminating Selection

4.04 The Model 43-01 can be bridged across the received line by setting the BRIDGE/TERM switch to the BRIDGE position. In the bridge mode, the send and receive levels are referenced to the selected terminating impedance (135 Ω, 600 Ω, or 900 Ω). When the Model 43-01 is going to terminate the received line, set the BRIDGE/TERM switch to the TERM position.

C. Normal/Reverse Selection

4.05 The NORM/REV switch enables the function of the send/receive jacks to be interchanged and may be used in 2-wire or 4-wire operation. When the NORM/REV switch is set to NORM, the right-hand jacks function as

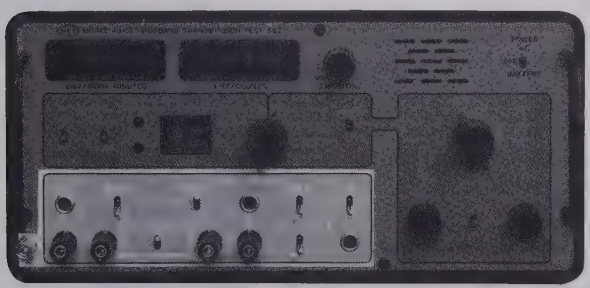


Figure 5. Line Interface Controls and Connectors

the SEND jacks and left-hand jacks function as the RCV (receive) jacks. Setting the NORM/REV switch to REV reverses the functions of the jacks with the right-hand jack becoming the RCV (receive) jack and the left-hand jack the SEND jack.

D. 2-Wire Line Interface

4.06 In order to interface to a 2-wire line, proceed as follows:

1) Set DIAL-TALK/MEAS to MEAS (option).
2) If it is necessary to hold the line under test, set HOLD/OFF to HOLD (option).
3) Set BRIDGE/TERM to the desired position (see paragraph 4.04).
4) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
5) Set the NORM/REV switch to NORM in order to send.
6) Set the NORM/REV switch to REV in order to receive.
7) Set the 2W/4W switch to 2W (option).
8) Connect the 2-wire line under test to either the NORM-SEND 310 jack or 5-way binding posts.

4.07 Since the Model 43-01 is optionally available with electronic hold circuits for both the SEND and RCV jacks, the NORM-RCV jacks can also be used for 2-wire line interface.

E. 4-Wire Line Interface

4.08 To interface with 4-wire lines, proceed as follows:

1) Set DIAL-TALK/MEAS to MEAS (option).
2) Set HOLD/OFF to OFF (option).
3) Set BRIDGE/TERM to the desired position (see paragraph 4.04).
4) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
5) Set the NORM/REV switch to NORM.
6) Set the 2W/4W switch to 4W (option).
7) Connect the send line to the NORM-SEND 310 jack or 5-way binding posts.
8) Connect the receive line to the NORM-RCV 310 jack or 5-way binding posts.

F. 2-Wire Dial-Up

4.09 The Model 43-01 is equipped with a versatile dial/talk circuit that enables a lineman's handset (butt-in) to be used in 2-wire operation. The following instructions assume that the dialing facility used has a listener output. If a simple dial is used that does not have an audible listener output, the Model 43-01's internal monitor speaker and volume control can be used to determine the presence of a dial tone and that the called line answered after dialing. In order to perform the following procedure, a lineman's handset (butt-in) or equivalent dialing facility (e.g. telephone set with a rotary dial) is required.

4.10 To dial-up on a single 2-wire wet line, proceed as follows:

1) Set the HOLD/OFF switch to OFF.
2) Set DIAL-TALK/MEAS to DIAL/TALK.
3) Set 2W/4W to 2W.
4) Set BRIDGE/TERM to the desired position (see paragraph 4.04).
5) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
6) Set the NORM/REV switch to NORM.
7) For single 2-wire line, connect the line under test to the NORM SEND 310 jack or 5-way binding posts.
8) Connect the Model 43-01 chassis ground post to the local ground or the sleeve (shield) of the 2-wire line undergoing test.
9) Connect the lineman's handset to the DIAL/TALK 310 jack.
10) Depress the off-hook button or turn on the off-hook switch on the lineman's handset.
11) Listen for a dial tone from the handset, then proceed to dial the desired number.

12) When the call is answered, set the HOLD/OFF switch to the HOLD position.
13) To return to the testing mode of operation, set the DIAL-TALK/MEAS switch to the MEAS position.

4.11 To dial-up on a double 2-wire line, proceed as follows:

1) Set the HOLD/OFF switch to OFF.
2) Set DIAL-TALK/MEAS to DIAL/TALK.
3) Set 2W/4W to 2W.
4) Set BRIDGE/TERM to the desired position (see paragraph 4.04).
5) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
6) Set the NORM/REV switch to NORM.
7) Connect the first line under test to the NORM SEND 310 jack or 5-way binding posts.
8) Connect the Model 43-01 chassis ground post ⏚ to the local ground or the sleeve (shield) of either 2W line undergoing test.
9) Connect the lineman's handset to the DIAL/TALK 310 jack.
10) Depress the off-hook button or turn on the off-hook switch on the lineman's handset.
11) Listen for the dial tone from the handset, then proceed to dial the desired number.
12) When the call is answered, set the HOLD/OFF switch to the HOLD position.
13) Connect the second line under test to the NORM RCV 310 jack or 5-way binding posts.
14) Set the NORM/REV switch to REV. The lineman's handset is now connected to the NORM RCV jack.
15) Verify that a dial tone is present in the lineman's handset when the off-hook button is depressed.
16) Dial the second desired number.
17) When the calling party answers, set the DIAL-TALK/MEAS switch to MEAS in order to place both lines in the normal test mode of operation.
18) The lineman's handset is now disconnected from both lines and can be unplugged or left plugged into the DIAL/TALK 310 jack without affecting tests or measurements.

Note: To redial because of any error or a busy line during any of the previous procedures, simply momentarily release or switch off the off-hook switch on the lineman's handset. Then redial the desired number as previously discussed.

4.12 Supervisory talk/listen functions can interrupt normal measurements at any time by reconnecting the lineman's handset to the DIAL/TALK 310 jack and setting the DIAL-TALK/MEAS switch to the DIAL/TALK position. To access the right-hand jacks, set the NORM/REV switch to the NORM position and to access the left-hand jacks, set the NORM/REV switch to the REV position. Normal measurement operation can be restored by setting the DIAL-TALK/MEAS switch to MEAS, as long as the HOLD/OFF switch is left in the HOLD position.

The lineman's handset can be used as a private monitor of the signal being measured by the Model 43-01 by connecting the lineman's handset to the DIAL/TALK 310 jack and setting the 2W/4W switch to the 4W position. To avoid local sidetones and acoustical noise pick-up, set the lineman's handset off-hook switch to the on-hook position. This is a convenience when the sound from the Model 43-01 monitor may be objectionable to others in the vicinity or when privacy is desired. Using this method, the lineman's handset monitors the selected receive pair with a nominal fixed gain of 0 dB.

G. 2W Answer

4.13 The Model 43-01 can answer an incoming call in two different ways. The first method uses the facilities provided by the Model 43-01, whereas the second method uses a lineman's handset or equivalent external facility. The first method can be used only where one 2-wire line is being answered. If two 2-wire lines are to be answered, it is necessary to use the second method.

4.14 First Method

Set the Model 43-01 switches to the following configuration:

1) BRIDGE/TERM to BRIDGE.
2) HOLD/OFF to OFF.
3) Connect the incoming 2-wire line to the NORM RCV 310 jack or 5-way binding posts.
4) Set DIAL-TALK/MEAS to MEAS.
5) Set the measure function switch to LEVEL.
6) Turn on the MONITOR volume.
7) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
8) Listen for the incoming ring. When the ringing signal is heard, turn the HOLD/OFF switch to the HOLD position. The line is now answered.
9) Set BRIDGE/TERM to the desired position (see paragraph 4.04).
10) Set NORM/REV to NORM to receive on a 2-wire line. Set NORM/REV to REV to send on a 2-wire line.

4.15 Second Method

To perform this method, a lineman's handset is required. Perform the following procedure:

1) Set HOLD/OFF to OFF.
2) Select DIAL-TALK/MEAS to DIAL/TALK.
3) Set 2W/4W to 2W.
4) Set BRIDGE/TERM to BRIDGE.
5) Connect the 2-wire lines to be answered to the NORM SEND and the NORM RCV 310 jacks.
6) Set the 135 Ω/900 Ω/600 Ω switch to match the line impedance.
7) Connect the lineman's handset to the DIAL/TALK 310 jack. Make sure the lineman's handset switch is set to the on-hook position.
8) When an incoming call is identified, answer by setting the lineman's handset switch to the off-hook position.
9) Set the HOLD/OFF switch to HOLD.
10) If only one 2-wire line is being answered, go to the normal measurement mode by setting the DIAL-TALK/MEAS switch to the MEAS position.
11) If a second 2-wire line is to be answered, set NORM/REV to REV and leave the DIAL-TALK/MEAS switch in the DIAL/TALK position.
12) Set the lineman's handset switch to the on-hook position.
13) When an incoming call is identified, answer it by setting the lineman's handset switch to the off-hook position.
14) To go to the normal measurement mode of operation, set the DIAL-TALK/MEAS switch to the MEAS position.
15) Select BRIDGE or TERM as desired for the receive 2-wire line (see paragraph 4.04).
16) Select send or receive by setting the NORM/REV switch to the appropriate position. (See paragraph 4.05).

4.16 After going to the normal measurement mode of operation, the lineman's handset may be left connected to the Model 43-01 and be used as a monitor for the receive signal by setting the 2W/4W switch to 4W.

5. RECEIVE LEVEL AND FRE - QUENCY MEASUREMENT

5.01 This section describes the operating procedure for the Model 43-01 when performing receive level and frequency measurements.

5.02 Overrange and underange condition indicators are provided to alert the operator when the level and/or frequency of the signal being measured exceeds the measurement capacities of the Model 43-01. Refer to Figure 6 while performing the procedures in this section.

A. Measurement

5.03 To perform a receive level and frequency measurement, proceed as follows:

1) Perform the required line interface procedures in Section 4.
2) Set the measure function knob to the LEVEL position.
3) The left-hand display will indicate the receive level in dBm referenced to the selected terminating impedance.
4) The right-hand display will indicate the received frequency in kHz. The right-hand display will have a maximum frequency reading capability of 19.999 kHz when the GENERATOR knob is set to the VF (4), .403, 1.004, or 2.809 positions. The frequency counter will read up to 199.99 kHz when the GENERATOR knob is set to the WB (120) or the PROG (20) positions.

B. Overrange and Underrange Indications

5.04 If the receive signal exceeds the measurement capacities of the Model 43-01, one of the following overrange or underrange indications will occur:

1) If the level goes above +10 dBm, the left-hand display will blank with the exception of the positive sign indicating that level overrange condition exists.
2) If the level goes below -90 dBm, the left-hand display will blank with the exception of a negative sign, indicating that a level underrange condition exists.

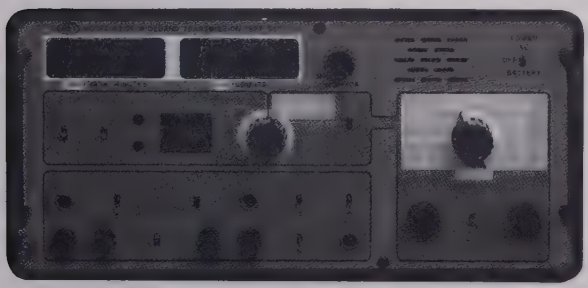


Figure 6. Receive Level and Frequency Measurements

3) If the received frequency is above 19.99 kHz when the GENERATOR knob is in the VF (4), .403, 1.004 or 2.809 positions or above 199.99 kHz when the GENERATOR knob is in the WB (120) or PROG (20) positions the righthand display will blank with the exception of a positive sign.
4) If the received frequency is below the measurement capability of the Model 43-01 the right-hand display will indicate all zeros.

6. NOISE MEASUREMENT

6.01 This section describes the operating procedure for the Model 43-01 when performing noise measurements. The user can make the following noise-weighted filter measurements:

1) C-message with or without tone.
2) 3 kHz flat with or without tone.
3) Program with or without tone.
4) 15 kHz flat with or without tone.
5) 50 kBit (497 F) with or without tone
6) 50 kHz flat with or without tone.

Refer to Figure 7 while performing the procedures in this section.

A. Measurement

6.02 To perform a noise measurement, proceed as follows:

1) Perform the line interface procedures given in Section 4.
2) Set the measure function knob to NOISE (W/T) to measure the noise on channels having a holding tone. If a holding tone is not on the channel, set the measure function knob to the NOISE (WO/T) position.
3) Set the WGTD/FLAT switch to the WGTD position if C-message, program or 50 kBit (497 F) filter weighting is required. Set the WGTD/FLAT switch to the FLAT position if 3 kHz flat, 15 kHz flat, or 50 kHz flat filter weighting is desired.
4) Set the GENERATOR knob to the VF (4) position for C-message or 3 kHz flat weighting. Set the GENERATOR knob to PROG (20) for program or 15 kHz flat weighting. Set the GENERATOR knob to the WB (120) position for 50 kBit (497F) and 50 kHz flat weighting.

Note: With the GENERATOR knob set to the .403, 1.004 or 2.809 positions the C-message or 3 kHz flat weighting filters are selected depending upon the position of the WGTD/FLAT switch.

5) The left-hand display will indicate the received noise expressed in dBrn.

6.03 The right-hand display will be blank during noise measurements.

6.04 The user can determine the signal-to-noise ratio of a channel with holding tone by first measuring the circuit noise with the measure function knob set to the NOISE

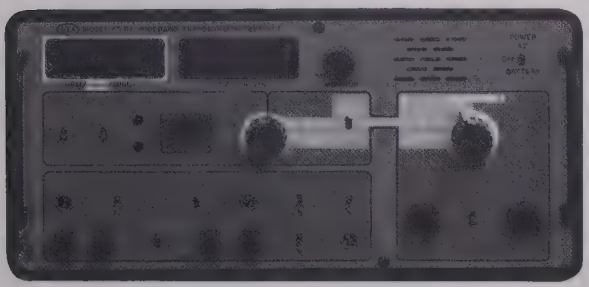


Figure 7. Noise Measurement

(WO/T) position, and then measuring the circuit noise with the measure function knob in the NOISE (W/T) position. By subtracting the second reading from the first, the user can determine the signal-to-noise ratio of the channel.

B. Overrange and Underrange Indications

6.05 If the received noise goes above +100 dBrn, the left - hand display will blank with the exception of the positive sign indicating that an overrange condition exists.

6.06 If the received noise goes below -99 dBrn, the left - hand display will blank with the exception of the negative sign indicating that an underrange condition exists.

7. IMPULSE NOISE MEASUREMENT

7.01 This section discusses the operating procedures for the Model 43-01 when performing impulse noise measurements. Refer to Figure 8 while performing the procedures in this section.

WARNING: Do not change any front panel switch settings once the impulse noise measurement is started. Doing so may cause invalid data to be recorded

7.02 To perform impulse noise measurements, proceed as follows:

1) Perform line interface procedures given in Section 4.
2) Set the DBRN thumbwheel switches to the desired low threshold level.

Note: Threshold spread between LOW and MID and MID and HI is preset to 4 dB.

3) Set the TIMER MINUTES switch to 5, 15, or CONT as desired.
4) Set the WGTD/FLAT switch to WGTD for C-message, Program, 50 kBIT (497 F) filter weighting. Set the WGTD/FLAT switch to FLAT for 3 kHz flat, 15 kHz flat, or 50 kHz flat filter weighting.
5) Set the GENERATOR knob to VF (404) for C-message or 3 kHz flat. Set the GENERATOR knob to PROG (20) for Program, or 15 kHz flat. Set the GENERATOR knob to WB (120) for 50 kBit (497F) or 50 kHz flat filter weighting.

Note: With the GENERATOR knob set to the .403, 1.004 or 2.809 positions the C-message or 3 kHz flat weighting filters are selected depending upon the position of the WGTD/FLAT switch.

6) Momentarily press the TIMER START/STOP switch to the START position.
7) The left-hand display will indicate the elapsed time in minutes that the impulse noise measurement has been in process.
8) By setting the measure function knob to the LOW, MID, and HI positions, the right-hand display will indicate the accumulated low, mid, and high impulse noise counts, respectively.

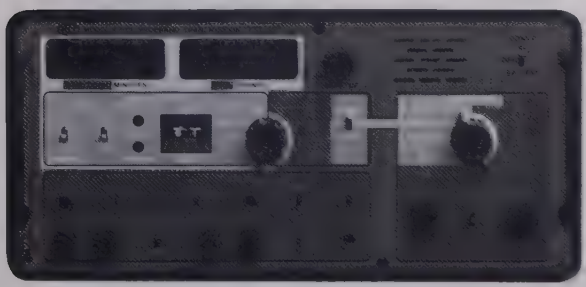


Figure 8. Impulse Noise Measurement

7.03 The TONE PRESENT indicator will be lit whenever a valid holding tone is present. If for any reason, the holding tone is lost during impulse noise measurements, the TONE INTERRUPT indicator will light and remain lit until the impulse noise measurement is started again.

7.04 The user can monitor the receive level and frequency without affecting the impulse noise measurement by setting the measure function switch to the LEVEL position.

8. SEND LEVEL AND FREQUENCY SETUP

8.01 This section describes the send level and frequency setup procedures for the Model 43-01. Refer to Figure 9 while performing the procedures in this section.

8.02 In order to set up the send level, proceed as follows:

1) Perform the line interface procedures in Section 4.
2) Set the measure function knob to SEND.
3) Set the LEVEL VAR/−16DBM/QUIET switch to the VAR position for a variable level adjustment, to −16DBM for fixed −16 dBm output level, or to QUIET for quiet termination on a send line.
4) If the LEVEL VAR/-16 DBM/QUIET switch is set to the VAR position, adjust the LEVEL VAR knob for the desired send level as indicated in the left-hand display of the Model 43-01.

8.03 Perform the following steps for the send frequency setup:

1) Set the GENERATOR knob to the WB (120) position for a variable generator from 1250 Hz to 120 kHz. Set the GENERATOR knob to PROG (20) for a variable generator from 250 Hz to 24 kHz. Set the GENERATOR knob to the VF (4) position for a variable generator from 50 Hz to 4.8 kHz. When the GENERATOR knob is in any of the three previous positions, the VAR knob is used to set the send frequency within the indicated ranges. The right-hand display will display the send frequency.
2) For fixed frequencies of 403, 1004, or 2809 Hz, set the GENERATOR knob to the .403, 1.004 or 2.809 position, respectively.

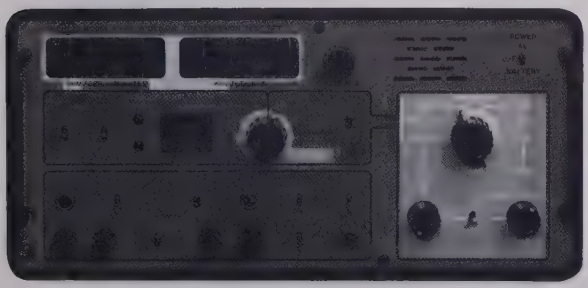


Figure 9. Send Level and Frequency Setup

9. MONITOR

9.01 This section describes the operation of the Model 43-01 audio monitor. Refer to Figure 10.

9.02 The Model 43-01 MONITOR provides automatic gain control (AGC) when the measure function knob is in the LEVEL, NOISE (W/T), NOISE (WO/T) or SEND position. A fixed gain, determined by the DBRN thumbwheel setting, is provided when the measure function knob is in the LOW, MID or HI position.

Since up to 90 dB of AGC is provided, the noise background will change dramatically when the measure function knob is in the LEVEL, NOISE (W/T), NOISE (WO/T) or the SEND position.

Any user-selected filter weighting can be applied to the monitor signal. In the case when the measure function knob is set to the NOISE (WO/T) position, the user can monitor any of the noise weighting filter signals without the notch in-line.

When the measure function knob is set to the LOW, MID, HI or NOISE (W/T) position, the signal being monitored is the selected noise weighting filter plus the notch which removes any 1 kHz test tone that may be present. This provides the user with the ability to listen to the notched output with fixed gain when in the LOW, MID or HI modes or with a notched AGC'd output in the NOISE (W/T) mode as desired. This is particularly useful in trouble-shooting certain types of noise and crosstalk problems.

9.03 The volume of the monitor signal is controlled by the MONITOR knob. The user can turn the monitor off by setting this knob to the OFF position.

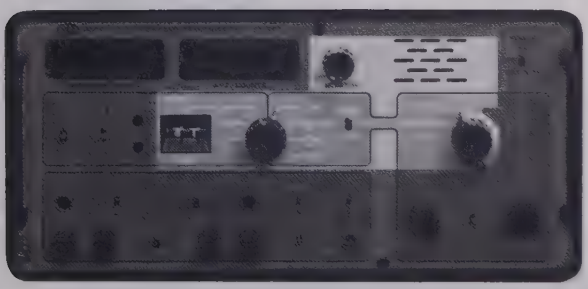


Figure 10. Monitor

10. SELF-TEST

10.01 This section describes the procedure for self-testing the Model 43-01. These procedures are to be used for self-test purposes only, and are not intended for calibration. Calibration procedures are contained in the Model 43-01 Service Manual (P/N 43-01-M30). A looping cord is required to do the self-test. Perform the following self-test procedures in sequence. Refer to Figure 11.

A. Initial Switch Settings

1) Connect the ac power cord to the rear panel receptacle and power source.
2) Connect the looping cord from the NORM REC jack to the NORM SEND jack.
3) Set BRIDGE/TERM to the TERM position.
4) Set HOLD/OFF to OFF (option).
5) Set DIAL-TALK/MEAS to MEAS (option).
6) Set the TIMER 5/15/CONT switch to the 5 position.
7) Set the DBRN thumbwheel switches to 76.
8) Set the measure function knob to SEND.
9) Set WGTD/FLAT to FLAT.
10) Set the GENERATOR knob to 1.004.
11) Set the LEVEL VAR/−16DBM/QUIET switch to −16DBM.
12) Set the POWER switch to the AC position.
13) Adjust the MONITOR knob for a comfortable listening level.

B. Generator, Level Meter and Frequency Counter Checks

1) With the initial switch settings completed the left-hand display should read -16.0 dBm ±0.1 dB and the right-hand display should read 1.004 kHz ±0.001 kHz.
2) Set the GENERATOR knob to 2.809. The left-hand display should read −16.0 dBm ±0.2 dB. The right hand display should read 2.809 kHz ±0.001 kHz.
3) Set the GENERATOR knob to .403. The left-hand display should read −16.0 dBm ±0.2 dB. The right-hand display should read 0.403 kHz ±0.001 kHz.
4) Set the GENERATOR knob to the VF (4) position.
5) Set the VAR knob fully counterclockwise.

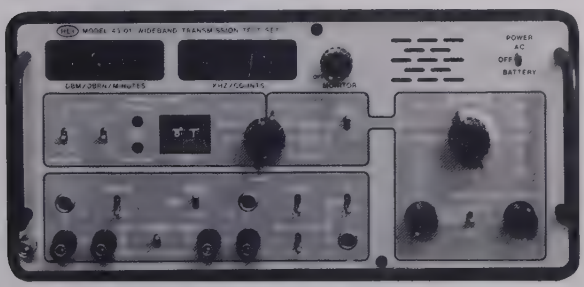


Figure 11. Self - Test

6) Slowly rotate the VAR knob clockwise. Verify that the left-hand display reads −16.0 dBm ±0.2 dB over the frequency range and the right-hand display goes from a minimum of 0.050 kHz or less to a maximum of at least 4.800 kHz.
7) Set the GENERATOR knob to the PROG (20) position.
8) Set the VAR knob fully counterclockwise.
9) Slowly rotate the VAR knob clockwise. Verify that the left-hand display reads −16.0 dBm ±0.5 dB over the frequency range. Also verify that the right-hand display goes from a minimum of 0.25 kHz or less to a maximum of at least 24.00 kHz.
10) Set the GENERATOR knob to the WB (120) position.
11) Set the VAR knob fully counterclockwise.
12) Slowly rotate the VAR knob clockwise. Verify that the left-hand display reads −16.0 dBm ±0.5 dB over the frequency range. The right hand display should go from a minimum of 1.25 kHz or less to a maximum of at least 120.00 kHz.
13) Set the GENERATOR knob to the 1.004 position.
14) Set the LEVEL VAR/−16 DBM/QUIET switch to the QUIET position. Verify that the left-hand display blanks with the exception of a negative sign and the right-hand display reads all zeroes.
15) Set the LEVEL VAR/−16 DBM/QUIET switch to the VAR position.
16) Set the LEVEL VAR knob fully counterclockwise. Verify that the left-hand display reads −40 dBm or less.
17) Slowly rotate the LEVEL VAR knob clockwise. Note that the left-hand display reading steadily increases to +10 dBm or more when the fully clockwise position is reached.
18) Set the LEVEL VAR/−16 DBM/QUIET switch to the −16 DBM position.
19) Set the measure function knob to the LEVEL position. Note that the left-hand display reads −16.0 dBm ±0.1 dB and the right-hand display reads 1.004 kHz.

C. Noise Meter and Filter Checks

1) Set the measure function knob to NOISE (WO/T).
2) Set the WGTD/FLAT switch to FLAT.
3) Set the GENERATOR knob to 1.004. Verify that the left-hand display reads 74 dBrn ±1 dB.
4) Set the GENERATOR knob to 2.809. Verify that the left-hand display reads 72 dBrn ±1 dB.
5) Set the WGTD/FLAT switch to WGTD Verify that the left-hand display reads 72 dBrn ±1 dB.
6) Set the GENERATOR knob to 1.004. Verify that the left-hand display reads 74 dBrn ±1 dB.
7) Set the GENERATOR knob to .403. Verify that the left-hand display reads 63 dBrn ±1 dB.
8) Set the GENERATOR knob to 1.004.
9) Set the measure function knob to NOISE (W/T). Note that the left-hand display reading is 24 dBrn or less.
10) Set the measure function knob to the SEND position.
11) Set the GENERATOR knob to PROG (20).
12) Adjust the VAR knob for a frequency reading of 0.40 kHz in the right-hand display.
13) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 65 dBrn ±2 dB.
14) Set the measure function knob to SEND.
15) Adjust the VAR knob for a frequency reading of 1.00 kHz in the right-hand display.
16) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 74 dBrn ±1 dB.
17) Set the measure function knob to SEND.
18) Adjust the VAR knob for a frequency reading of 10.00 kHz in the right-hand display.

19) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 66 dBrn ±4 dB.
20) Set the measure function knob to SEND.
21) Set the WGTD/FLAT switch to FLAT.
22) Adjust the VAR knob for a frequency reading of 15.00 kHz in the right-hand display.
23) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 71 dBrn ±1 dB.
24) Set the measure function knob to SEND.
25) Adjust the VAR knob for a frequency reading of 1.00 kHz in the right-hand display.
26) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 74 dBrn ±1 dB.
27) Set the measure function knob to SEND.
28) Set the GENERATOR knob to WB (120).
29) Adjust the VAR knob for 2.00 kHz.
30) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 74 dBrn ±1 dB.
31) Set the measure function switch to SEND.
32) Adjust the VAR knob for 50.00 kHz.
33) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 71 dBrn ±1 dB.
34) Set the measure function knob to SEND.
35) Set the WGTD/FLAT switch to WGTD.
36) Adjust the VAR knob for 1.25 kHz.
37) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 74 dBrn ±1 dB.
38) Set the measure function knob to SEND.
39) Adjust th VAR knob for 37.00 kHz.
40) Set the measure function knob to NOISE (WO/T). Verify that the left-hand display reads 68 dBrn ±2 dB.

D. Impulse Noise Check

1) Set the GENERATOR knob to 1.004.
2) Set the measure function switch to LOW.
3) Momentarily press START/STOP to the START position. Note the TONE PRESENT indicator is lit and the TONE INTERRUPT indicator is not lit.
4) Remove the looping cord and note that the TONE PRESENT indicator is not lit and the TONE INTERRUPT indicator is lit.
5) Reconnect the looping cord. Note that the TONE PRESENT indicator is lit and that the TONE INTERRUPT indicator remains lit.
6) Momentarily press START/STOP to the START position. Note that the TONE INTERRUPT indicator is not lit.
7) Set the GENERATOR knob to WB (120).
8) Set the WGTD/FLAT switch to FLAT.
9) Set the measure function switch to SEND.
10) Adjust the VAR knob for 2.00 kHz.
11) Momentarily press START/STOP to the START position.
12) Set the measure function switch to LOW, then MID and then HI. Note that the LOW counter is counting and the MID an HI counters are not counting.
13) Set the DBRN thumbwheel switches to 72.
14) Set the measure function switch to LOW, then MID and then HI. Note that the LOW and MID counters are counting and the HI counter is not counting.
15) Set the DBRN thumbwheel switches to 68.
16) Set the measure function switch to LOW, then MID and then HI. Note that the LOW, MID and HI counters are counting.
17) Set the DBRN thumbwheel switches to 60.

18) Momentarily press START/STOP to the START position.

19) After the TIMER times out at 5.0 minutes. use the measure function switch to read the LOW. MID and HI counts. Note they all read 2100 counts ±10%.

11. BOARD INSTALLATION/ REMOVAL

11.01 This section describes the procedures for installation/removal of individual boards in the Model 43-01. Only the boards and assemblies described below are normally field serviced.

11.02 As shown in Figure 12, the Model 43-01 contains the following boards:

- Digital
- Generator
- Analog
- Input/Output (I/O)
- Power Supply

DANGER: Hazardous voltages exist inside this instrument. Disconnect power cord from unit before proceeding.

11.03 To remove and install individual boards in the Model 43-01, proceed as follows:

1) Remove the screws from the side and bottom of the Model 43-01. Refer to Figure 13.
2) Pull the case off the unit.
3) Disconnect the two Molex connectors from the Power Supply board. (Only if power supply board is to be removed).

WARNING: The Generator board must be removed before the Digital board can be removed.

4) Remove the Digital, Generator and Power Supply boards by pulling the boards from the rear of the unit.

WARNING: To avoid damaging the Analog and Input/Output boards, they must be removed together.

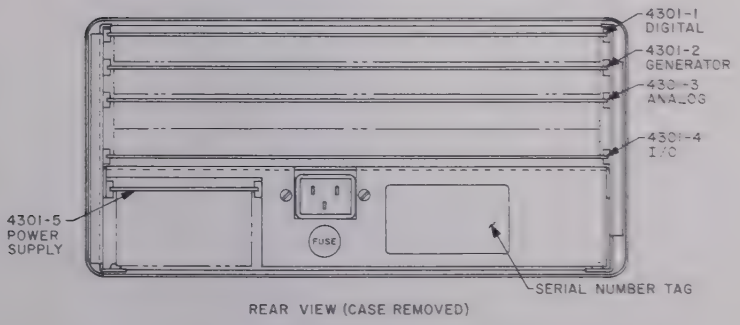


Figure 12. Model 43-01 PC Board Identification

5) Pull the Analog board toward the rear approximately ¼ inch.
6) Pull the Input/Output board toward the rear approximately ¼ inch.
7) Grasp both the Analog and Input/Output boards, and pull rearward until they both clear the unit.
8) To install the boards, reverse the removal procedure, and gently slide them into the Model 43-01 together until they are firmly seated in the edge connector.
9) Replace the Model 43-01 case.

11.04 For repair or servicing by HLI, refer to Section 12.

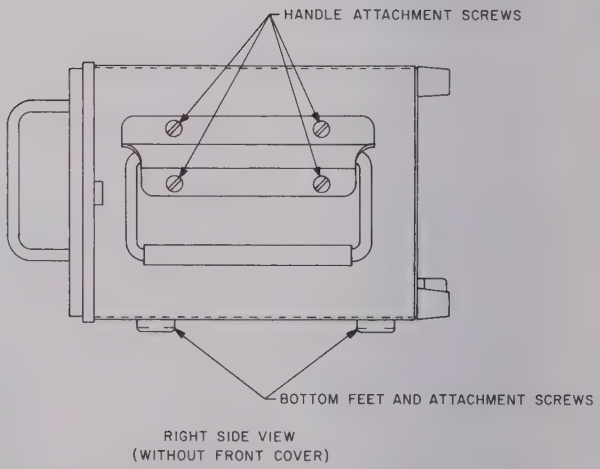


Figure 13. Assembly/Disassembly Screw Locations

12. PACKING, SHIPPING, AND RETURN TO FACTORY

12.01 This section contains procedures to be followed when returning the Model 43-01, or individual boards to the factory for repair or servicing.

Note: Most problems with the Model 43-01 can be isolated to the individual board level because of functional organization. It is recommended, therefore, that the factory be consulted by telephone or letter before shipping the unit.

A. Complete Unit

12.02 The original packing materials and shipping container for the Model 43-01 should be stored for use when shipment, between customer locations or return to factory, becomes necessary.

12.03 If the unit is being returned to HLI for repair or servicing, enclose the following information:

- Type of repair or service required
- Model number and serial number
- Return address
- Listing of symptoms if repair is required
- Name and telephone number of person to contact concerning the repair or service

Keep a copy of all information for yourself and refer to your copy in any correspondence with the factory.

12.04 If original packing materials and shipping container are unavailable, repack the unit as follows:

1) Wrap the unit in heavy paper or plastic. Tape loose edges.
2) Surround the wrapped unit in 2 to 4 inches (5 to 10 cm.) thick shock-absorbing material.
3) Place the package in a strong, double-walled shipping container. Fill excess spaces with newspaper.
4) Seal the container securely.
5) Mark the container: FRAGILE - DELICATE ELECTRONIC INSTRUMENT.

B. Boards

12.04 To remove boards from Model 43-01, refer to Section 11.

C. Individual Boards

12.06 When a board has been extracted from the Model 43-01, handle the board by the top and bottom edges of the board only. DO NOT handle the rear edge connector. Static electricity may damage the CMOS IC's on the board(s).

12.07 If the board is being returned to HLI for servicing or repair, enclose the following information:

- Type of service or repair required
- Model and serial number of the Model 43-01 from which the board was extracted
- Serial number of the board
- Return address
- Listing of symptoms if repair is required
- Name and telephone number of person to contact concerning the repair or service

Retain a copy of all information for yourself and refer to your copy in any correspondence with HLI.

12.08 Boards shipped separately from the factory are enclosed in a special conductive envelope that protects the circuitry from static electricity. This protective envelope should be retained and used for reshipment. If the conductive envelope is not available, DO NOT wrap the board in an ordinary plastic bag or plastic sheeting. Instead, proceed as follows:

1) If available, cover the entire rear edge connector with a conductive shorting bar

2) Wrap the board in heavy kraft paper.
3) Surround the wrapped unit in 2 to 4 inches (5 to 10 cm.) thick shock-absorbing material.
4) Place the package in a strong, double-walled shipping container. Fill excess spaces with newspapers.
5) Seal the container securely.
6) Mark the container: FRAGILE - DELICATE ELECTRONIC INSTRUMENT

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